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## **2007 Engine Mechanical**

**Model: All 2007 with 6-Cylinder**

**Production: from 9/2006**

# **OBJECTIVES**

After completion of this module you will be able to:

- Understand the basic mechanical features of the N54, N52KP and N51
- Understand the differences between the N54 and N52

## Engine Construction

Of the three new 6-cylinder engines for 2007, the N54 has perhaps the most changes in comparison with the N52. Beginning with the crankcase, the N54 engine uses an all aluminum alloy block with cast cylinder liners. The aluminum crankcase is pressure cast and differs from the “insert” design of the N52. This design is in contrast to the previous composite magnesium/aluminum crankcase on the N52. The construction of the N54 crankcase is to accommodate the increased torque output of the turbocharged N54.

Dimensionally, the N54 crankcase is the same as the N52 and continues to use the 2-piece crankcase with bedplate. There are some slight differences regarding the bolt pattern for the transmission mounting. This requires a new engine mounting bracket when installing on to the engine stand.

### **All aluminum (AL226 alloy) crankcase - N54**



The crankshaft is forged steel on the N54 engine. The crankshaft on the N52KP and N51 engines remains cast iron as on the original N52.

## Engine Mechanical Changes

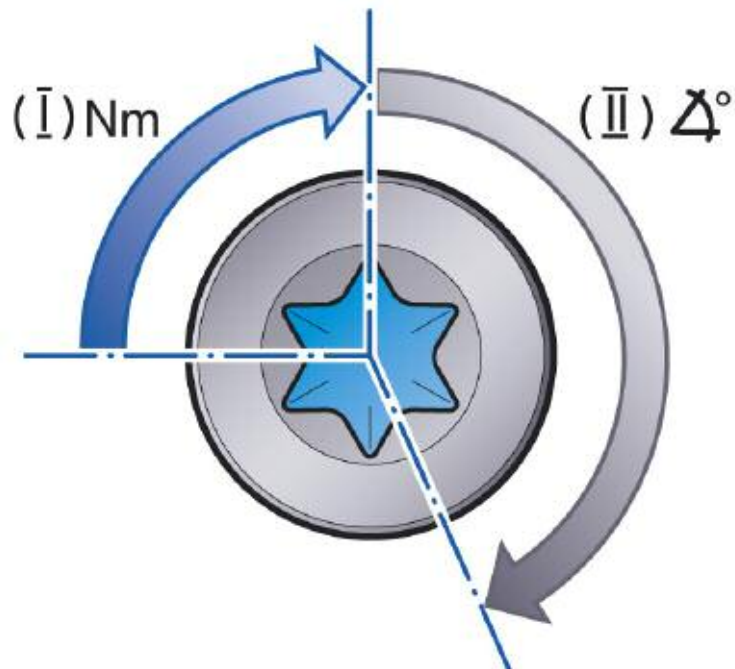
### Bolts

As with the N52, the N54 continues to use the aluminum bolts for most fastening duties. Even though the N54 is an all aluminum crankcase, the aluminum bolts are used to reduce any confusion. This decreases the possibility of any incorrectly installed bolts of the wrong material (steel vs. aluminum). Of course, the N52KP and N51 still retains the use of aluminum bolts as well.



The same rules apply to the handling and installation of aluminum bolts as in the past. Strict adherence to repair instructions is required to ensure proper connections.

Be sure to use the proper torque/tightening angle sequence as indicated in the “tightening torques” section of TIS.



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## Cylinder Head Cover

The cylinder head covers on all of the new engines have changed. While the N52 uses a magnesium cylinder head cover, the new engines use a plastic cover. The N52KP and N51 use the same basic design to accommodate the VVT motor and new crankcase ventilation system. In comparison, the N54 uses a completely different design. This is due to the lack of Valvetronic and the modified crankcase ventilation system.

The bolts that secure the cylinder head cover are steel.



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## Cylinder Head

As far as the cylinder head designs are concerned, all three of the new engines use a different cylinder head. While all of the heads are made from aluminum, they differ due to the design requirements. For example, the N54 does not use Valvetronic and requires accommodation for the fuel injectors for direct injection. The N52KP engine uses a cylinder head which is mostly identical to the N52. The N51, which is a SULEV II design, uses a lower compression ratio and therefore a different cylinder head with a modified combustion chamber.

### Cross-section of N54 Cylinder Head



### ■ Valvetrain

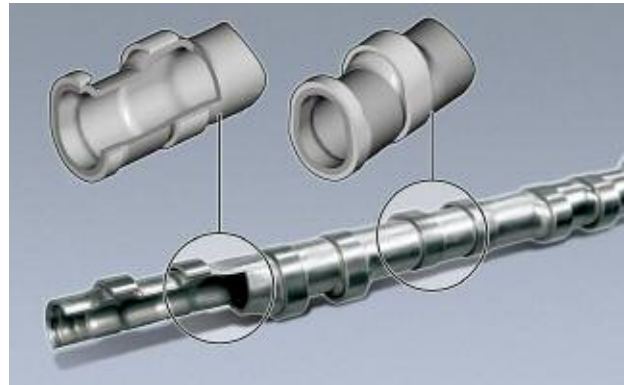
With regard to the valvetrain changes, the intake valves still use the 5mm stem from the N52. However, the exhaust valves have been upgraded to a 6mm valve stem for increased durability. The 6mm exhaust stem has also been in production on the current N52 since 3/06.

The valves have solid construction and the valve head diameters are engine specific.

## Camshafts

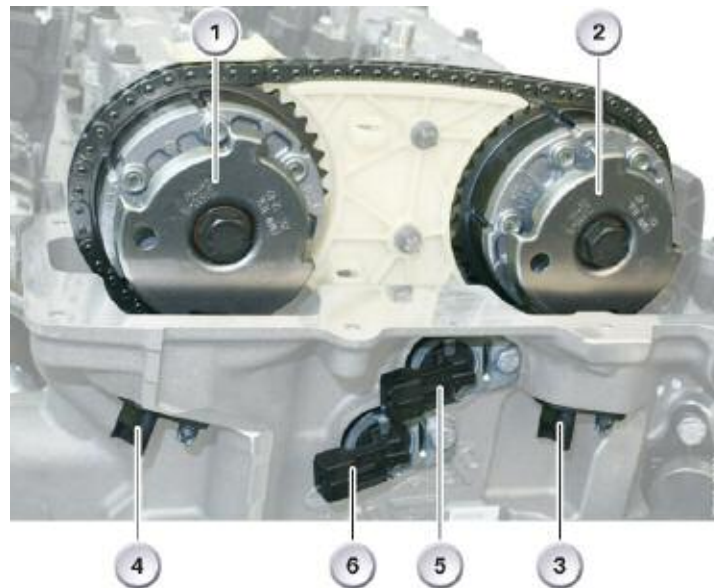
All of the new engine variants will take advantage of the lightweight, hydroformed camshafts from the N52. For supply and production reasons, it is possible that some engines may be fitted with cast camshafts.

Consequently, it is possible to interchange these camshafts with no problem. Cast camshafts and hydroformed camshafts can be fitted as replacement parts. It is even possible to have cast and hydroformed camshafts on the same engine as well.



## VANOS

The infinitely variable double VANOS system is still in use on all NG6 engines. The system still retains the use of the lightweight VANOS units from the N52. The only change to the system is that the N54 uses different spread ranges as compared to the other engines (N52, N52KP and N51). As with the previous systems, the VANOS units should not be mixed up as the spread ranges for the intake and exhaust are different and engine damage could result.



Index	Explanation	Index	Explanation
1	VANOS unit, Exhaust	4	Exhaust camshaft sensor
2	VANOS unit, intake	5	VANOS solenoid valve
3	Intake camshaft sensor	6	VANOS solenoid valve

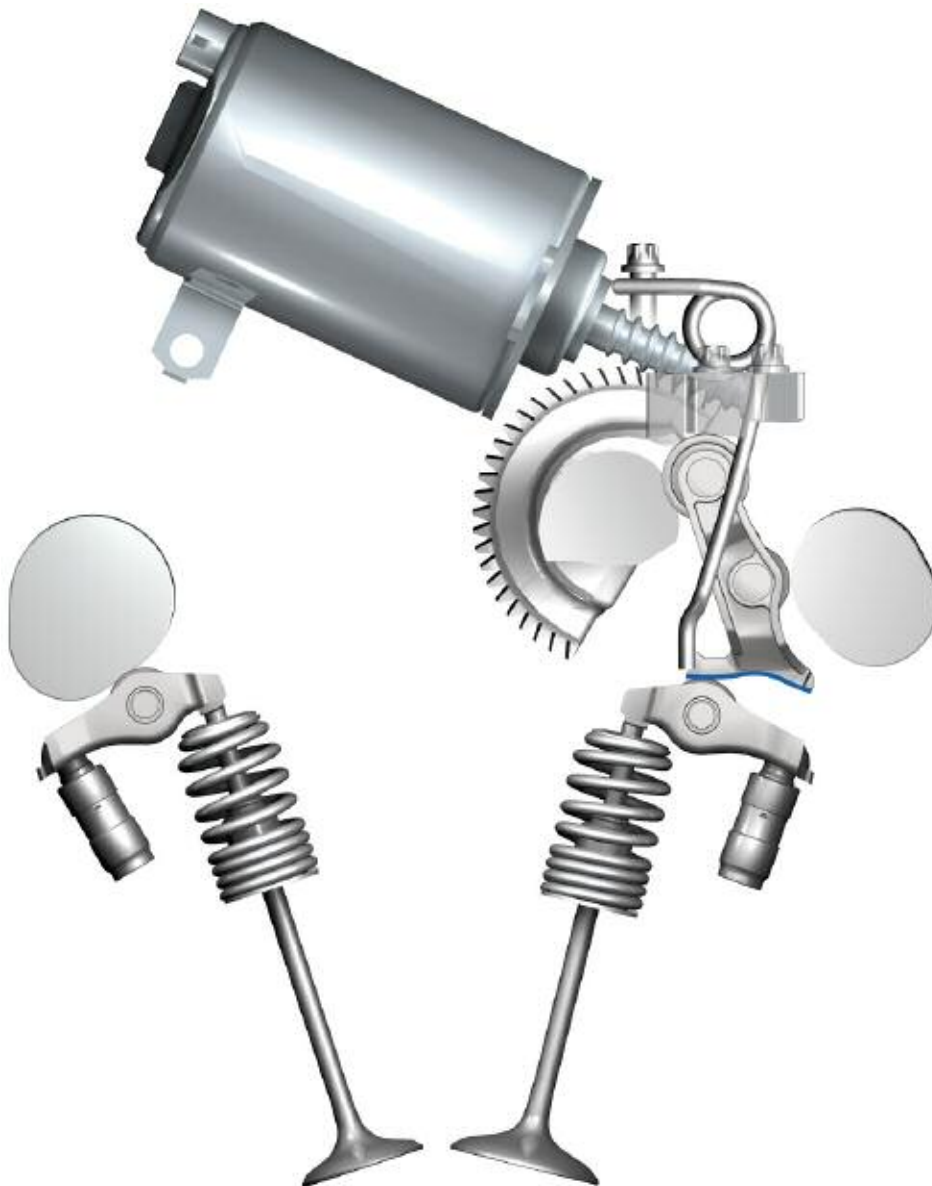
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## Valvetronic

The N52KP and N51 retain the already proven Valvetronic system. The only changes to the system for 2007 is an optimized VVT motor.

On the other hand, the N54 engine does **NOT** use Valvetronic. This is due to the fact that the Valvetronic system is designed to reduce pumping losses. It is a system which improves volumetric efficiency by optimizing the air charge.

A turbocharger system is also designed to increase volumetric efficiency by reducing pumping losses. Therefore, there is no need for both of these systems to be employed on the same engine. The N54 gains maximum efficiency by the use of turbocharging and direct injection.





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## **Gaskets and Seals**

The gasket design on the new engines is mostly similar to the N52. The N54 uses a specific head gasket for use with the turbocharged application. The head gasket is a multi-layered design which does not have the protruding lip as on the N52. This lip is not needed due to the fact that the cylinder head is aluminum and contact corrosion is not an issue.

The split crankcase still uses the injected sealant carried over from the N52.

## **Piston and Connecting Rods**

As with the cylinder head, the piston designs differ between engines. The N54 uses a special piston for compatibility with the direct injection system. The piston crown is modified to meet the mixture formation requirements.

The N51 engine uses a lower compression ratio and accordingly uses a different piston design. The N52KP uses the same design as the N52 engine.

The connecting rods on all of the NG6 engines have been stiffened with a thicker beam on the rod. This design has also been in production on the N52 since 6/06.

## **Crankshaft**

The cast iron crankshaft is retained for the N52KP and N51. To accommodate the increased power output of the N54, the crankshaft is forged steel.

## **Torsional Vibration Damper**

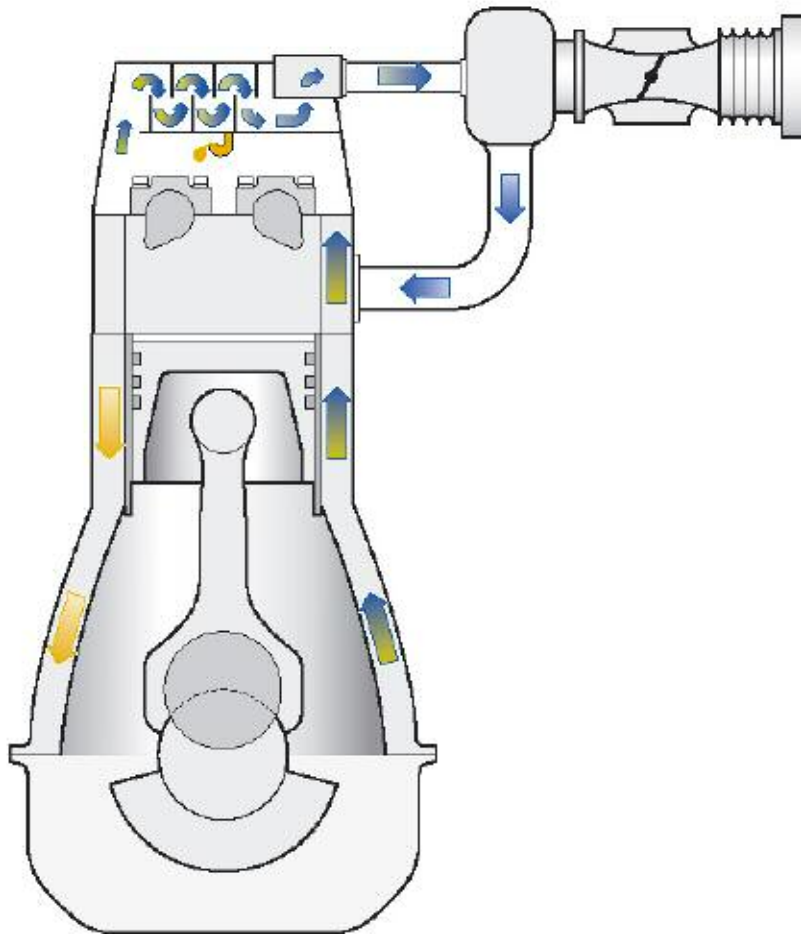
The torsional vibration damper has need optimized to improve damping of first order vibrations. The damper is secured with new bolts and the tightening procedure has been changed. These procedures should not be confused with the N52 as damage to the belt drive could result.

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## Crankcase Ventilation

There are two basic methods for ventilating the crankcase which have been in use a BMW engines. One of the methods uses a crankcase ventilation valve and the other does not. In either case, the crankcase vapors must be metered into the intake and the oil must be separated from the vapors.

The basic crankcase ventilation system is shown below. It features the “labyrinth” method of oil separation which uses a maze of channels to divide the crankcase vapor from the liquid oil. The vapors can enter the engine through a “calibrated” orifice, while to liquid oil returns back into the engine or oil sump.



In the case of the three new NG6 engines, there are two methods employed. The N54 engine does not use a crankcase ventilation valve and oil is separated using the “cyclonic method”.

The N52KP and N51 engines use a crankcase ventilation valve and the “labyrinth” method of oil separation.

## N54 Crankcase Ventilation

The crankcase ventilation system on the N54 engine is unique due to the fact that this is a turbocharged engine. This means the the intake manifold pressure will be higher than that of a naturally aspirated engine. This presents new challenges regarding the design of the crankcase ventilation system.

The basic description of the system is as follows:

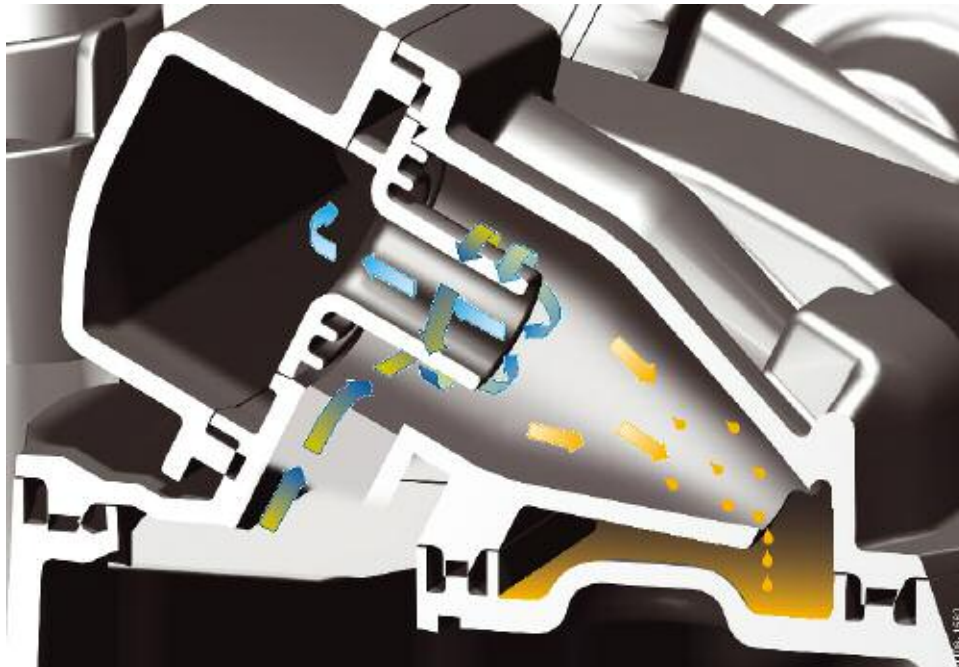
- The system uses a calibrated orifice to meter crankcase vapors into the engine
- Liquid oil is separated from the crankcase vapors is done by “cyclonic” action
- There are 2 channels for crankcase vapors depending upon the manifold pressure
- Most of the system components are integrated into the cylinder head cover

One of the most important features is the fact that most of the system components are integrated into the plastic cylinder head cover. This allows engine heat to warm the crankcase vapors which prevents any potential freezing of any water vapor trapped in the system. In contrast to the N52, there is only one heating element located at the intake manifold inlet.

### ■ Cyclone Separator

A cyclone oil separator is used in the N54 engine. Here, four of the described cyclones are integrated into the oil-separator housing. The oil mist drawn in from the crankcase is set into a spinning motion in the cyclone. As a result of the centrifugal forces, the heavier oil settles on the cyclone walls and from there drips into the oil drain.

The lighter blow-by gases are sucked out from the middle of the cyclone. The purified blow-by gases are then fed to the air-intake system.



## Crankcase Ventilation System Function

The crankcase ventilation system of the N54 must be capable of venting the crankcase during two different modes of engine operation. When the engine is in deceleration, the intake manifold pressure is low (high vacuum). During acceleration or idling, the intake manifold pressure is higher (low vacuum). Therefore the system operates differently in these modes. This is what is unique about the crankcase venting system on the N54.



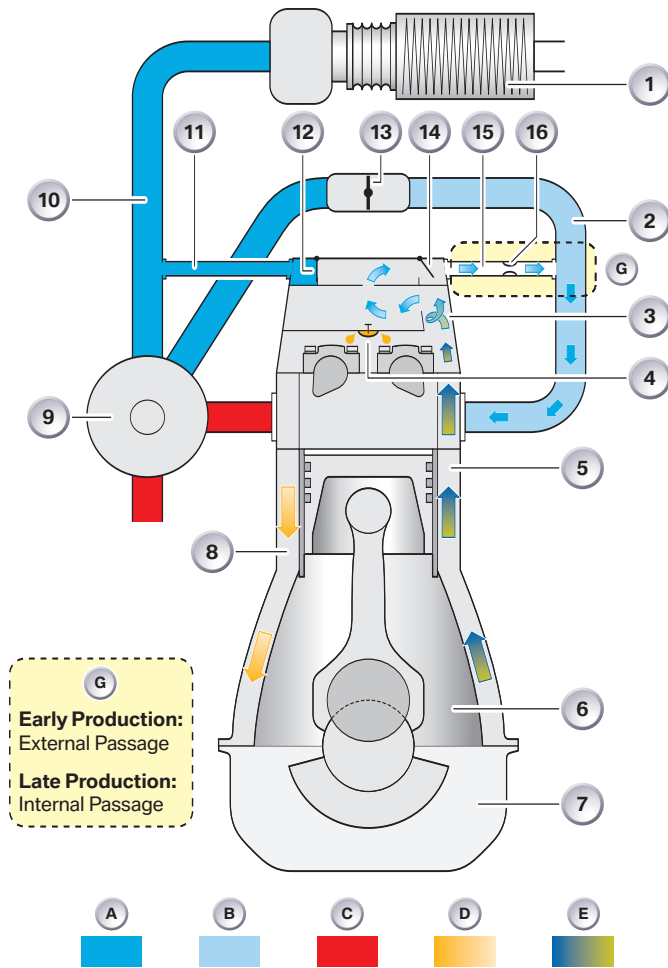
Index	Explanation	Index	Explanation
1	Check valve, charge air suction line	3	Check valve, manifold and pressure restrictor
2	Ventilation, turbocharged operation	4	Ventilation, naturally aspirated mode (decel)

### ■ Operation with Low Manifold Pressure

When the engine has low manifold pressure such as in decel, the crankcase vapors are routed through a channel (15) between the cylinder head cover and intake manifold. The liquid oil is separated before the channel in the cyclonic separators (3) in the cylinder head cover. The liquid oil returns to the engine via the oil discharge valve (4).

The channel contains a pressure restrictor (16) which regulates the flow of crankcase vapors. During deceleration, the crankcase vapors (E) are directed via a check valve (14) which is located in the cylinder head cover. The check valve is opened when low pressure is present in the intake manifold (throttle closed).

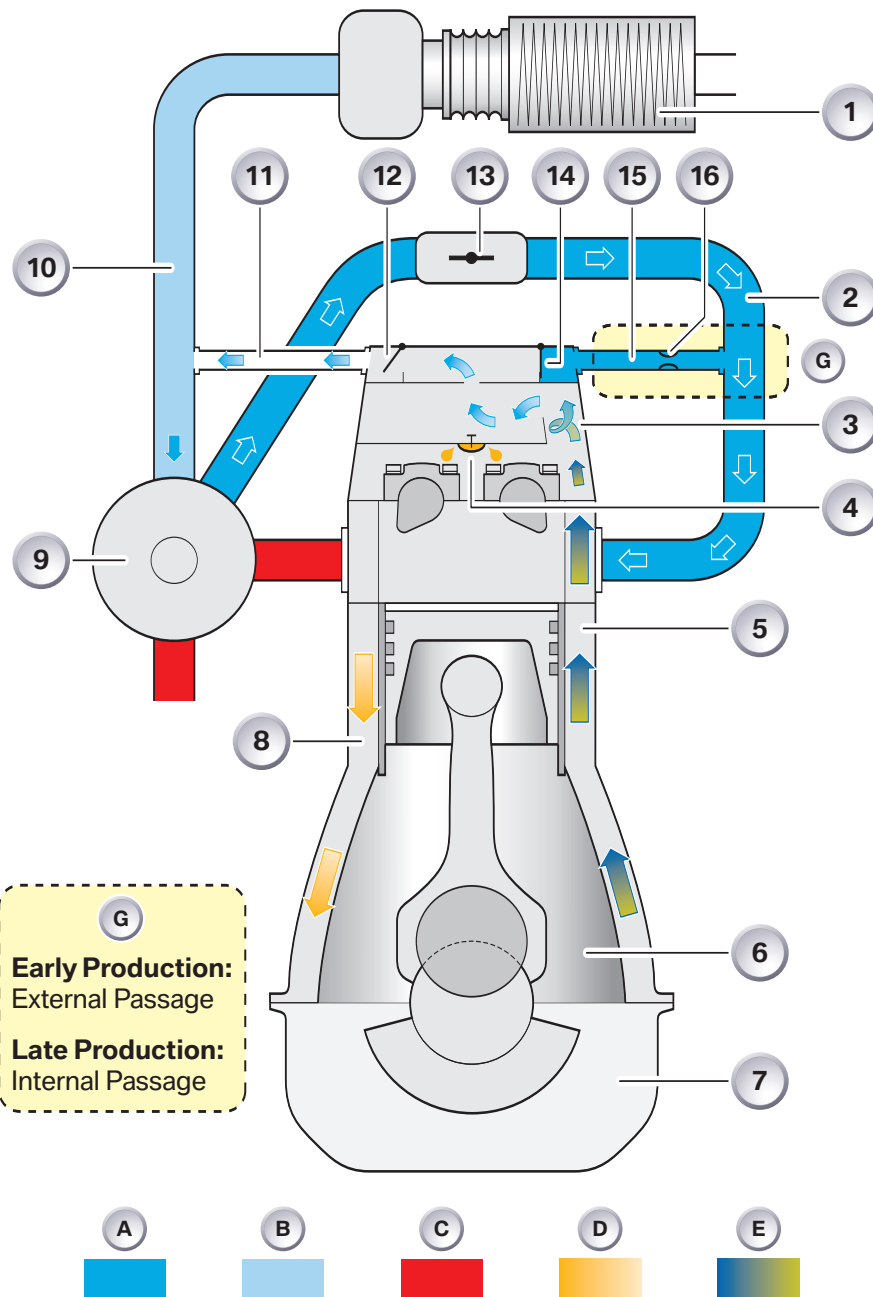
Also, a PTC heater has been integrated into the intake manifold inlet. The inlet pipe is connected to the channel (15) and prevent any moisture from freezing at the inlet.



Index	Explanation	Index	Explanation
A	Overpressure	7	Oil sump
B	Low Pressure (Vacuum)	8	Oil return channel
C	Exhaust gas	9	Turbocharger
D	Liquid oil	10	Charge air suction line, bank 2
E	Blow-by gases (Crankcase vapors)	11	Hose to charge air suction line, bank 2
1	Air cleaner	12	Check valve, manifold
2	Intake manifold	13	Throttle valve
3	Cyclone separators	14	Check valve, charge air suction line
4	Oil discharge valve	15	Channel to intake manifold
5	Venting channel	16	Pressure restrictor
6	Crankshaft cavity		

### ■ Operation with High Manifold Pressure

When in turbocharged mode, the pressure in the intake manifold increases and then closes the check valve (14). Now, a low pressure is present in the charge air suction line (10). This causes a low pressure in the hose (11) leading to the manifold check valve (12). The crankcase vapors (after separation) are directed through the check valve (12) into the charge air suction line (10) and ultimately back into the engine. The check valve (12) also prevent boost pressure from entering the crankcase when the intake manifold pressure is high.



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6	Crankshaft cavity		

**Note: Be aware that any check valve failure could cause excessive oil consumption possibly accompanied by blue smoke from the exhaust. This should not be mistaken for a failed turbocharger. Always perform a complete diagnosis of the crankcase ventilation system, before replacing any turbocharger or associated components.**

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### **Crankcase Ventilation N52KP and N51**

The crankcase ventilation system on the N52KP and N51 uses a crankcase ventilation valve which is incorporated into the cylinder head cover. Oil is separated via an internal labyrinth which is also incorporated into the cylinder head cover.

This system, like the N54, also benefits from the integral components. This design allows engine heat to warm the crankcase vapors which decreases the likelihood of any moisture freezing in the system during conditions of low ambient temperature.



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